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# Turing's Problem Solved?

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## TURING'S PROBLEM SOLVED?

"Men are all alike."

"IN WHAT WAY?"

"They're always bugging us about something or other."

"CAN YOU THINK OF A SPECIFIC EXAMPLE?"

"Well, my boyfriend made me come here."

"YOUR BOYFRIEND MADE YOU COME HERE!"

"He says I'm depressed much of the time."

"I AM SORRY TO HEAR YOU ARE DEPRESSED."

. . .

"My father is afraid of everybody."

"WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER?"

"Bullies."

"DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE?"

Alan Turing had a problem. He could not tell whether he was communicating with another person or with a machine. This distinction can be very hard to make, as you will realize if you thought that the snatches of a conversation quoted above came from a psychiatrist's casebook. Actually this conversation was between a girl using a teletype (that is, a typewriter connected electrically to a distant terminal) and a computer programmed to reply by making simple grammatical transformations

of the information she gave it.

Turing, a brilliant British mathematician, first pointed to this problem of distinguishing human from machine responses in order to support his claim that everything which can be done by people can be done, in principle, by machines. After all, Von Neuman even designed a computer that could reproduce itself.

Insofar as their union rules permit them to agree on anything, philosophers agree that any human behavior can be imitated mechanically if it can be clearly specified. Thus computers are able to take over such clearly specifiable chores as doing sums, looking up records, and recognizing simple patterns. Computers can even draw pictures, write poems, and compose music. The catch is that if computer art is the kind you like, it is merely a pastiche. For example, Mozart invented a do-it-yourself kit: you compose a melody by throwing dice to make a series of selections from a set of carefully matched snatches of music. It is trivial to write an equivalent program for a computer connected to a loud-speaker system. The output may well be such that the listener is tricked into asking whether this is the melody of Köchel number 30,051, or whatever, because it conforms to the rules which Mozart observed in his compositions. Its style will certainly not be original. However, producing works with original styles is easy, because original styles, by definition, break away from the explicit or implicit rules to which previous works conformed. The simplest way to break the rules is to have the computer develop some fault so that it diverges in unexpected ways from its program. Now the output will probably be so original that

it is like nothing you ever heard before or ever want to hear again. The choice between pastiche and perversity is solely due to the fact that it is intrinsically impossible to give a clear specification for an acceptable work of art in an original style without actually producing such a work.

The way to discover whether your respondent at the other end of the teletype circuit is a computer or its operator might therefore appear to consist in demanding: "Produce me a work of art." Admittedly the computer can not distinguish between a work of art on the one hand and a banal or chaotic production on the other. Neither can you. Dear reader, I would not dare dispute the excellence of your taste, but you must agree that many other people are so aesthetically anaesthetized that they fail to appreciate the same things as you. Suppose, then, that the teletype outputs what it claims is a sonnet, and that you type back "You are nothing but a dumb computer because all you have sent me is fourteen lines of doggerel; that is no poem..." "It is so," comes the reply. Which of you is right?

That question can not be answered. That is to say, there is no certain way of deciding whether your correspondent has or has not carried out the behavior you requested. It follows that requesting an artistic production will not provide a criterion for solving Turing's problem.

Likewise there is no point in asking for a demonstration of an emotion that is allegedly the prerogative of humans, such as love. Divorce statistics provide enough proof that human beings often mistake

their own feelings, let alone other people's.

By this time we can see that there is at least one criterion which must be met by any behavior claimed to be unarguably human:

1. The behavior must be clearly recognizable, meaning that there must be no doubt as to whether it has or has not been performed.

Keeping that criterion in mind, let us try another approach. The characteristics of mechanical behavior are that they can be specified by a finite set of instructions which have the form, "If the data are such so-and-so, carry out such-and-such action," and "If the result of a previous action is so-and-so, carry out such-and-such action." Obviously, there must be a further requirement: each constituent action of a behavior must not only be clearly recognizable but also clearly and fully specifiable, so that a machine can be built to carry out that action, among others.

We may conclude that it would be possible to distinguish between a man and a machine by requesting the performance of a behavior which could not be done by a machine because it would include at least one action which can not be clearly and fully specified. Presumably making up a witty joke is such a behavior, because there is no way of clearly and fully specifying the essential action of thinking of the punch line. I say "presumably" because some wizard of systems analysis may one day devise a mechanical punch production line. However, until there is such an existence proof, it is merely idle speculation to maintain that wit could be mechanized. Unfortunately it is no use going to the teletype and tapping out the requirement, "Tell me a dirty joke that I have not

heard before." It could always be argued that the output was not funny and therefore not a joke. Wit, like art and love, can not be recognized by any objective test.

Anyhow, we have established a second criterion for a behavior to be used in establishing whether the mystery correspondent is human or not.

2. The behavior must involve at least one action which is not clearly specifiable, so that the behavior can not be mechanized.

A third criterion should also be laid down to rule out as far as possible behavior achieved by random processes.

3. The behavior must be accomplished reasonably often within a limited time of its being requested. That is not to say that every request for this behavior must be fulfilled--men, like machines, are fallible. I merely wish to make it unreasonable to argue, if the behavior is accomplished, that it could have been due to trial and error, which would generally be betrayed by its taking an unduly long time, or by its being preceded by an undue number of failures, or both.

I submit that there are at least two broad classes of behavior meeting these criteria: the devising of scientific theories and the devising of algorithms.

The term "algorithm" is used by mathematicians to impress laymen: it simply means a recipe. A computer program is an algorithm; so is the set of instructions on a carton of milk telling you how to open it; so is any complete set of rules for carrying out some task in a finite number of steps. Algorithms have been studied intensively by the Russian methematician Markov. He has proved that there are numerous classes of

of problem in mathematics for which no general method of solution exists. In other words, it may be impossible to construct a single algorithm to solve all problems of a certain kind, even if it is possible to construct a special algorithm to solve each individual problem of that kind. This means that for certain classes of problem there can be no algorithm for devising all the special algorithms needed to solve all the individual problems of that class. If there were, such an algorithm would itself solve all the problems, which is what Markov has shown to be impossible. A number of algorithms can be derived algorithmically. However, because the number of possible tasks is infinite, the chances of there being an algorithm for constructing an algorithm for any one given task is infinitesimal. Therefore it is virtually impossible that an algorithm for a given task could have been arrived at mechanically except by trial and error. But the likelihood is also infinitesimal of an algorithm for a given task being successfully constructed by a random process within a given time, because there is an infinity of sets of rules which could be constructed, all of which would have to be tested before a suitable set was found. Furthermore there can be no doubt as to whether a set of rules really is the desired algorithm: it is only if it works. Thus, devising an algorithm fits the three criteria for distinguish behavior as non-mechanizable. On the other hand, human beings are rather good at devising algorithms. So if the teletype satisfies your request for an algorithm, you can be virtually certain that there is a human being down the line.

The second class of clearly recognizable behaviors which are not mechanizable is the devising of scientific theories. The essential feature of a scientific theory is that it entails testable predictions. There can be no doubt as to whether a theory is feasible or not: a single falsified prediction and the theory is dead--or at least in need of major surgery if its life is to be saved. The important point is that until somebody makes an observation that does not fit the theory, there can be no doubt that it is feasible. Some experts may think the theory implausible--but while it fits the facts, it remains feasible. There may be alternative theories--but all are feasible as long as they fit the facts.

No computer has ever devised a feasible theory. Set an IBM 360/75 up in an orchard and bombard it with apples; it will not respond by devising a theory of gravitation. Why not? Because a Newton is capable of a flash of inspiration, a hunch, an intuition, an inductive leap, whereas the jumps in a computer program are never to that kind of conclusion.

Notice that by inductive leaps I do not mean hypotheses which can be arrived at on the basis of statistics, such as the horribly feasible hypothesis that smoking causes cancer. Trivially simple circuits can express hypotheses. By making an inductive leap I mean arriving at some explanation which introduces a completely new concept, as did the theories of gravitational attraction, of curved space-time, of atoms, electrons and benzene rings, of microbial action, of unconscious motivation, and of evolution.

Thus the construction of feasible theories satisfies two of our criteria for distinguishing a behavior that cannot be mechanized; there is no doubt when the behavior is accomplished, yet it involves an element, intuition, which can not be clearly specified and thus can not be performed according to a book of rules.

Theory construction also satisfies the third criterion, that the result could not be achieved by random action. A computer could be programmed to produce some statement more or less at random and then test whether this statement agreed with a given set of facts; if not, the statement would be rejected and a new statement produced. This process would continue until a statement was found which fitted all the given facts. This statement might then be considered to be a theory accounting for those facts. It can not be disputed that there are an infinite number of feasible theories that could account for a given set of facts. If we were to construct one of these theories by some random process, there would then be an infinitely small likelihood that it would be one such that the first prediction to be deduced from the theory would be fulfilled. Yet there are very few human theories which are disposed of at the first test: usually they withstand many more tests. If, therefore, your teletype produces a theory which withstands even a single test, the probability that you are communicating only with a computer becomes infinitely small.

Surely you could not ask for more in this uncertain world. Yet there is what Madison Avenue calls an added plus in this demonstration. Men are busy trying to prove by technological, intellectual and aesthetic

endeavors, that we are not far below the beasts, who do not destroy their own kind with the patriotic, racial or religious fervor of humanity. At least we have seen that, with respect to creativity, men are superior to the computers . . . though the nagging thought remains that computers have reached only their third generation.